

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **2003-009286**

(43)Date of publication of application : **10.01.2003**

(51)Int.Cl.

H04R 17/00

(21)Application number : **2001-
193305**

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(54) **PIEZOELECTRIC ELECTROACOUSTIC TRANSDUCER AND ITS
MANUFACTURING METHOD**

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a piezoelectric electroacoustic transducer with a stable frequency characteristics by applying an adhesive properly to fix a thin diaphragm to a case and of a conductive adhesive for electric connection between the diaphragm and the case so as to prevent distortion from occurring in the diaphragm.

SOLUTION: The piezoelectric electroacoustic transducer employs a 1st adhesive 13 that is applied to the shortest path tying a piezoelectric diaphragm 1 and interconnections 11a, 12a to fix the piezoelectric diaphragm to the case between the internal connections 11a, 12a of the outer circumferential part and the terminal of the rectangular piezoelectric diaphragm 1 in tortuous vibration in a broadwise direction by applying an alternate signal between electrodes, a conductive adhesive 14 that is applied between the electrodes and the internal connections of the terminal of the piezoelectric diaphragm via an upper face of the 1st adhesive 13 while bypassing the shortest path tying the piezoelectric diaphragm and the internal connections so as to electrically connect the electrodes and the internal connections of the terminal of the piezoelectric diaphragm, and a 2nd adhesive 15 that seals a gap between the outer circumferential part of the piezoelectric diaphragm and the inner circumferential part of the case.



LEGAL STATUS

[Date of request for examination]

27.11.2002

[Date of sending the examiner's

decision of rejection]

[Kind of final disposal of application
other than the examiner's decision of
rejection or application converted
registration]

[Date of final disposal for application]

[Patent number] 3700616

[Date of registration] 22.07.2005

[Number of appeal against examiner's
decision of rejection]

[Date of requesting appeal against
examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]

[Claim 1] The piezo-electric diaphragm of the square which carries out a
crookedness oscillation in the direction of board thickness by impressing an
alternation signal to inter-electrode, The insulating case of the square which has

the supporter which supports a piezo-electric diaphragm inside the side-attachment-wall section, The terminal electrode which the internal connection section exposed near [supporter] the above, and this internal connection section and the external connection through which it flows exposed to the outside surface of a case, It is applied to the shortest path which is between the periphery section of a piezo-electric diaphragm, and the internal connection section, and connects a piezo-electric diaphragm and the internal connection section, and a piezo-electric diaphragm between the 1st adhesives fixed to a case, and the internal connection section of the electrode of a piezo-electric diaphragm, and a terminal electrode The electroconductive glue which bypasses the shortest path which connects a piezo-electric diaphragm and the internal connection section, is applied through the top face of the 1st adhesives, and connects electrically the internal connection section of the electrode of a piezo-electric diaphragm, and a terminal electrode, It is the piezo-electric mold electroacoustic transducer characterized by having the 2nd adhesives which close the clearance between the periphery section of a piezo-electric diaphragm, and the inner circumference section of a case, and the 1st and 2nd adhesives of the above having the Young's modulus smaller than electroconductive glue in a hardening condition.

[Claim 2] The 1st adhesives of the above are piezo-electric mold electroacoustic transducers according to claim 1 characterized by having the property in which the viscosity in the condition of not hardening is high and cannot permeate easily, compared with the 2nd adhesives.

[Claim 3] The 1st adhesives of the above are piezo-electric mold electroacoustic transducers according to claim 1 or 2 characterized by being selectively applied near [four] the corner of a piezo-electric diaphragm.

[Claim 4] The above-mentioned electroconductive glue is a piezo-electric mold electroacoustic transducer according to claim 3 characterized by being applied to at least two of the places near [four] the corner of a piezo-electric diaphragm.

[Claim 5] The process which prepares the piezo-electric diaphragm of the square

which carries out a crookedness oscillation in the direction of board thickness by impressing an alternation signal to inter-electrode, The process for which the insulating case of the square which has the supporter which supports a piezo-electric diaphragm inside the side-attachment-wall section, and has the terminal electrode which the internal connection section exposed near [supporter] the above, and this internal connection section and the external connection through which it flows exposed outside is prepared, The process which the shortest path which is between the periphery section of a piezo-electric diaphragm and the internal connection section, and connects a piezo-electric diaphragm and the internal connection section is made to apply and harden the 1st adhesives, and fixes a piezo-electric diaphragm to a case, The top face of the 1st adhesives is minded between the internal connection sections of the electrode of a piezo-electric diaphragm, and a terminal electrode. And the process which bypasses the shortest path which connects a piezo-electric diaphragm and the internal connection section, is made to apply and harden electroconductive glue, and connects electrically the internal connection section of the electrode of a piezo-electric diaphragm, and a terminal electrode, It is the manufacture approach of the piezo-electric mold electroacoustic transducer characterized by making the clearance between the periphery section of a piezo-electric diaphragm, and the inner circumference section of a case apply and harden the 2nd adhesives, having the process which closes between both, and the 1st and 2nd adhesives of the above having the Young's modulus smaller than electroconductive glue in a hardening condition.

[Claim 6] The 1st adhesives of the above are the manufacture approaches of the piezo-electric mold electroacoustic transducer according to claim 5 characterized by having the property in which the viscosity in the condition of not hardening is high and cannot permeate easily, compared with the 2nd adhesives.

[Claim 7] The 1st adhesives of the above are the manufacture approaches of the piezo-electric mold electroacoustic transducer according to claim 5 or 6 characterized by being selectively applied near [four] the corner of a piezo-

electric diaphragm.

[Claim 8] The above-mentioned electroconductive glue is a piezo-electric mold electroacoustic transducer according to claim 7 characterized by being applied to at least two of the places near [four] the corner of a piezo-electric diaphragm.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a piezo-electric mold electroacoustic transducer and its manufacture approaches, such as a piezo-electric buzzer and a piezo-electric earphone.

[0002]

[Description of the Prior Art] Conventionally, in electronic equipment, home electronics, a portable telephone, etc., the piezo-electric mold electroacoustic transducer is widely used as the piezo-electric buzzer which generates an alarm tone and a sound of operation, or a piezo-electric earphone. Its thing of the structure which closed opening of a case with covering is common while this kind of piezo-electric mold electroacoustic transducer sticks a circular piezoelectric

device on one side of a circular metal plate, constitutes a uni-morph mold diaphragm, and silicone rubber is used for it and it supports the periphery section of a metal plate in a circular case. However, when the circular diaphragm was used, there was a trouble that productive efficiency was bad and it was difficult for sound conversion efficiency to constitute low and small.

[0003] Then, the piezo-electric mold electroacoustic transducer which enabled improvement in productive efficiency, the improvement in sound conversion efficiency, and a miniaturization is proposed by using a square diaphragm (JP,2000-310990,A). This piezo-electric mold electroacoustic transducer has a square piezo-electric diaphragm, and the bottom wall section and the four side-attachment-wall sections. The insulating case where had the supporter which supports a diaphragm inside the two side-attachment-wall sections which counter, and the 1st and the 2nd current carrying part for external connection were prepared in the supporter, While two sides and supporter with which it has the cover plate which has a sound emission hole, a diaphragm is contained in a case, and a diaphragm counters are fixed with adhesives or an elastic sealing agent. The clearance between remaining two sides and cases of a diaphragm is closed with an elastic sealing agent, a diaphragm and the 1st and 2nd current carrying part are electrically connected by electroconductive glue, and it has structure which the cover plate pasted up on the side-attachment-wall section opening edge of a case.

[0004]

[Problem(s) to be Solved by the Invention] the diaphragm used for a piezo-electric mold electroacoustic transducer in recent years -- dramatically -- thin -- becoming -- about dozens-100 micrometers -- thin -- the **** diaphragm is used. such -- thin -- when a **** diaphragm is used, the effect which the supporting structure has on frequency characteristics becomes large. For example, when direct continuation of between a diaphragm and external electrodes is carried out with the electroconductive glue of heat-curing molds, such as an urethane system, distortion occurs in a diaphragm by the hardening contraction stress of

electroconductive glue, and frequency characteristics vary. Moreover, when surrounding temperature changes, when a property changes with the coefficient-of-thermal-expansion differences of a case and a diaphragm or external force joins a case, the direct force is transmitted also to a diaphragm, and a property may change.

[0005] When electroconductive glue is applied to the shortest path which connects between the supporters of the two sides and the case where a diaphragm counters, i.e., the internal connection section through which it flows in an external electrode, even if it applies electroconductive glue on it after fixing a diaphragm and a case by elastic support material as mentioned above, the stress generated by hardening contraction of electroconductive glue may act on a diaphragm, and problems, like frequency characteristics vary may occur.

[0006] Then, the object of this invention is devising the spreading location of the electroconductive glue which performs the adhesives and electrical installation which fix a diaphragm to a case, prevents distortion of a diaphragm and is to offer the piezo-electric mold electroacoustic transducer whose frequency characteristics were stable, and its manufacture approach.

[0007]

[Means for Solving the Problem] In order to attain the above-mentioned object, invention concerning claim 1 The piezo-electric diaphragm of the square which carries out a crookedness oscillation in the direction of board thickness by impressing an alternation signal to inter-electrode, The insulating case of the square which has the supporter which supports a piezo-electric diaphragm inside the side-attachment-wall section, The terminal electrode which the internal connection section exposed near [supporter] the above, and this internal connection section and the external connection through which it flows exposed to the outside surface of a case, It is applied to the shortest path which is between the periphery section of a piezo-electric diaphragm, and the internal connection section, and connects a piezo-electric diaphragm and the internal connection section, and a piezo-electric diaphragm between the 1st adhesives fixed to a

case, and the internal connection section of the electrode of a piezo-electric diaphragm, and a terminal electrode. The electroconductive glue which bypasses the shortest path which connects a piezo-electric diaphragm and the internal connection section, is applied through the top face of the 1st adhesives, and connects electrically the internal connection section of the electrode of a piezo-electric diaphragm, and a terminal electrode. Having the 2nd adhesives which close the clearance between the periphery section of a piezo-electric diaphragm, and the inner circumference section of a case, the 1st and 2nd adhesives of the above offer the piezo-electric mold electroacoustic transducer characterized by the Young's modulus in a hardening condition being smaller than electroconductive glue.

[0008] The process which prepares the piezo-electric diaphragm of the square which carries out a crookedness oscillation in the direction of board thickness when invention concerning claim 5 impresses an alternation signal to inter-electrode, The process for which the insulating case of the square which has the supporter which supports a piezo-electric diaphragm inside the side-attachment-wall section, and has the terminal electrode which the internal connection section exposed near [supporter] the above, and this internal connection section and the external connection through which it flows exposed outside is prepared, The process which the shortest path which is between the periphery section of a piezo-electric diaphragm and the internal connection section, and connects a piezo-electric diaphragm and the internal connection section is made to apply and harden the 1st adhesives, and fixes a piezo-electric diaphragm to a case, The top face of the 1st adhesives is minded between the internal connection sections of the electrode of a piezo-electric diaphragm, and a terminal electrode. And the process which bypasses the shortest path which connects a piezo-electric diaphragm and the internal connection section, is made to apply and harden electroconductive glue, and connects electrically the internal connection section of the electrode of a piezo-electric diaphragm, and a terminal electrode, The clearance between the periphery section of a piezo-electric diaphragm and

the inner circumference section of a case is made to apply and harden the 2nd adhesives, it has the process which closes between both, and the 1st and 2nd adhesives of the above offer the manufacture approach of the piezo-electric mold electroacoustic transducer characterized by the Young's modulus in a hardening condition being smaller than electroconductive glue.

[0009] In this invention, after fixing between the periphery section of a diaphragm, and the internal connection sections of a terminal electrode with the 1st adhesives, between the internal connection sections of the electrode of a piezo-electric diaphragm and a terminal electrode is electrically connected with electroconductive glue. At this time, the 1st adhesives are applied and hardened by the shortest path which is between the periphery section of a piezo-electric diaphragm, and the internal connection section, and connects a piezo-electric diaphragm and the internal connection section, and through the top face of the 1st adhesives, electroconductive glue bypasses the shortest path which connects a piezo-electric diaphragm and the internal connection section, and is applied and hardened. Since the 1st adhesives are smaller than electroconductive glue, it is eased by the 1st adhesives and the Young's modulus in a hardening condition does not carry out the direct action of the stress generated by hardening contraction of electroconductive glue to a piezo-electric diaphragm. Therefore, distortion of a piezo-electric diaphragm does not occur and frequency characteristics do not vary. Moreover, since the 1st adhesives mitigate stress also when external force joins the time of surrounding temperature changing, and a case, stress hardly affects a piezo-electric diaphragm, but it can prevent that frequency characteristics change.

[0010] After facing manufacturing the piezo-electric mold electroacoustic transducer of this invention and containing a piezo-electric diaphragm in a case, the 1st adhesives may be applied, and before containing a piezo-electric diaphragm in a case, the 1st adhesives may be applied the periphery section of a piezo-electric diaphragm, or near the supporter of a case. In the case of the former, the 1st adhesives are applied using a dispenser, but adhesion

immobilization of the case of the latter may be carried out by applying the 1st adhesives to the edge of a piezo-electric diaphragm not only using the approach of using a dispenser but using a trowel etc., and containing this piezo-electric diaphragm in a case.

[0011] Like claim 2, compared with the 2nd adhesives, the 1st adhesives have the high viscosity in the condition of not hardening, and what has the property which cannot permeate easily is desirable. That is, when the viscosity in the condition of not hardening has the 1st low adhesives, the 1st adhesives close the internal connection section of the electrode of a piezo-electric diaphragm, or a terminal electrode in being easy to permeate, and applying electroconductive glue, it may become difficult to make it flow with the internal connection section of the electrode of a piezo-electric diaphragm or a terminal electrode. Moreover, the 1st adhesives may not remain in the shortest path part which connects the periphery section and the internal connection section of a piezo-electric diaphragm. Then, by using the 1st adhesives of the property which cannot permeate easily, such a problem is solved, the shortest path can be certainly bypassed with electroconductive glue, and a piezo-electric diaphragm and a terminal electrode can be connected.

[0012] Like claim 3, it is good to apply the 1st adhesives selectively near [four] the corner of a piezo-electric diaphragm. As the 1st adhesives, when the adhesives of a heat hardening mold are used, as for the center section of four sides of a case, deformation becomes large, and, also in the stress to a piezo-electric diaphragm, stress acts on the center section of four sides greatly. On the other hand, if the 1st adhesives are selectively applied near [four] the corner of a piezo-electric diaphragm, since deformation of a case is small, there will be little effect on a piezo-electric diaphragm at the time of hardening of the 1st adhesives, and it will end at it.

[0013] Electroconductive glue may be applied to at least two of the places near [four] the corner of a piezo-electric diaphragm like claim 4. Although generating of a piezo-electric diaphragm of distortion can be controlled if the 1st adhesives

are selectively applied near [four] the corner of a piezo-electric diaphragm like claim 3, effect of distortion by the stress generated by hardening contraction of electroconductive glue can be further lessened still like claim 4 by applying electroconductive glue to at least two in the 1st adhesives.

[0014] With the manner of support, a diaphragm may carry out a crookedness oscillation in the case where a crookedness oscillation is carried out in die-length bending mode, and area crookedness mode. The former is the mode which carries out a crookedness oscillation in the direction of board thickness by using the die-length direction both ends as the supporting point. two diagonal line locations which the latter uses four sides or four points as the supporting point, and make the principal plane of a diaphragm -- max -- it becomes a variation rate -- as -- that is, the intersection of the diagonal line -- max -- a variation rate -- it is the mode in which the whole area of a diaphragm carries out a crookedness oscillation in the thickness direction so that it may become an amount.

[0015] In this invention, the conductive paste of an urethane system is desirable as electroconductive glue. What has the Young's modulus lower than an electroconductive glue agent in a hardening condition as the 1st adhesives is used, for example, urethane system adhesives can be used. As the 2nd adhesives, Young's modulus is still lower than the 1st adhesives, and the low thing of hardening contraction stress is also good, for example, silicone system adhesives can be used. In addition, although it is also possible to use the adhesives of a room-temperature-setting mold as the 1st and 2nd adhesives, since hardening is started in the middle of spreading in case it applies by a dispenser etc., it is easy to generate plugging in a dispenser, and workability is bad. On the other hand, if it is the adhesives of a heat-curing mold, since viscosity is fixed in ordinary temperature, viscosity does not change in the middle of spreading, and plugging does not occur in a dispenser, but there is an advantage that workability is good.

[0016]

[Embodiment of the Invention] Drawing 1 - drawing 5 show the piezo-electric

mold electroacoustic transducer of the surface mount mold which is the 1st operation gestalt of this invention. This electroacoustic transducer fits the application used with single frequency like a sounder or a ringer, and consists of the diaphragms 1, the cases 10, and cover plates 20 of a profile and a uni-morph mold.

[0017] As shown in drawing 5, a diaphragm 1 has electrode 2a of a thin film or a thick film, and 2b at the table rear face, and the piezo-electric plate 2, the piezo-electric plate 2, and width method of four square shapes by which polarization was carried out in the thickness direction are the same, and are formed in a square with a little long linear dimension, and it consists of metal plates 3 by which pair face bonding was carried out to rear-face electrode 2b of the piezo-electric plate 2 through electroconductive glue etc. In addition, rear-face electrode 2b may be omitted and rear-face electrode 2b may be omitted by joining a metal plate 3 to the rear face of the piezo-electric plate 2 directly through electroconductive glue etc. In this example, the location where the piezo-electric plate 2 inclined toward the one-side side of the die-length direction to the metal plate 3 is pasted, and it has outcrop 3a which the metal plate 3 exposed in the other side side of the die-length direction of a metal plate 3.

[0018] As a piezo-electric plate 2, electrostrictive ceramics, such as PZT, is used, for example. Moreover, a metal plate 3 has a desirable ingredient with the as near Young's modulus of phosphor bronze, 42nickel, etc. with the desirable for example, ingredient which combines right conductivity and spring elasticity as the piezo-electric plate 2. Here, ceramics (PZT etc.) and a coefficient of thermal expansion used the metal plate made from 42nickel near and whose vertical x horizontal x thickness are 10mmx10mmx0.05mm as a metal plate 3. Moreover, the PZT plate whose vertical x horizontal x thickness is 8mmx10mmx0.05mm as a piezo-electric plate 2 was used.

[0019] The case 10 is formed in the core box of four square shapes which have bottom wall section 10a and the four side-attachment-wall sections 10b-10e with insulating ingredients, such as ceramics or resin. When it constitutes a case 10

from resin, heat-resistant resin, such as LCP (liquid crystal polymer), SPS (syndiotactic polystyrene), PPS (polyphenylene sulfide), and epoxy, is desirable. 10f of annular level difference sections was prepared in the inner circumference of the four side-attachment-wall sections 10b-10e, and the internal connection sections 11a and 12a of the terminals 11 and 12 of the couple which is a terminal electrode are exposed on 10f of level difference sections of the inside which are the two side-attachment-wall sections 10b and 10d which counter. Insert molding of the terminals 11 and 12 is carried out to a case 10, and the external connections 11b and 12b which projected in the exterior of a case 10 are bent to the base side of a case 10 along the outside surface which are the side-attachment-wall sections 10b and 10d. this example -- the internal connection sections 11a and 12a of terminals 11 and 12 -- two forks -- a ** -- separating -- **** -- these two forks -- it is located near the both ends whose internal connection sections 11a and 12a of a ** are 10f of level difference sections, and, moreover, the internal connection sections 11a and 12a are making the shape of an inverse triangle [breadth at last].

[0020] Inside 10f of level difference sections, as shown in drawing 3 , 10g of annular supporters for supporting the periphery of a diaphragm 1 is formed lower one step than 10f of level difference sections. Therefore, if a diaphragm 1 is laid on 10g of supporters, the top panel of a diaphragm 1 and the top face of the internal connection sections 11a and 12a of terminals 11 and 12 will become the same height mostly. In addition, 1st sound emission hole 10k is formed in bottom wall section 10a, and 10l. of notches used as the 2nd sound emission hole is formed in the rising wood of side-attachment-wall 10e (refer to drawing 1 and drawing 4).

[0021] The above-mentioned diaphragm 1 is contained in a case 10 so that a metal plate 3 may turn to bottom wall section 10a of a case 10, and four sides are laid on 10g of supporters of a case 10. And adhesion immobilization of near [four] the corner of a diaphragm 1 is carried out by the elastic support material (the 1st adhesives) 13. That is, adhesion immobilization of the shortest path

which connects outcrop 3a and internal connection section 11a between internal connection section 11a of a terminal 11 near the both ends of outcrop 3a of a metal plate 3 that is, is carried out by the elastic support material 13, and adhesion immobilization of between internal connection section 12a of a terminal 12 this and near the both ends of the side which counters is carried out by the elastic support material 13. In this example, the elastic support material 13 applied to the corner of one vertical angle of a diaphragm 1 is not restricted to this, although the elastic support material 13 which is an oblong ellipse form or an ellipse and is applied to the corner of the vertical angle of another side along the side side of a diaphragm 1 is a circular letter of a drop by drop titration. As elastic support material 13, the urethane system adhesives of 3.7×10^6 Pa are used, for example for the Young's modulus after hardening. Moreover, since it has the property which cannot permeate easily more highly (for example, 50 - 120 dPa-s) than the elastic sealing agent 15 which the viscosity in the condition of this elastic support material 13 of not hardening mentions later, when the elastic support material 13 is applied, the elastic support material 13 rises to Yamagata. Heat hardening is carried out after applying the elastic support material 13. In addition, as the fixed approach of a diaphragm 1, after containing a diaphragm 1 in a case 10, the elastic support material 13 may be applied by a dispenser etc., but where the elastic support material 13 is beforehand applied to a diaphragm 1, a diaphragm 1 may be held in a case 10.

[0022] The diaphragm 1 fixed to the case 10 by the elastic support material 13 and the internal connection sections 11a and 12a of terminals 11 and 12 are electrically connected with electroconductive glue 14. That is, it applies to an ellipse form so that the elastic support material 13 top to which electroconductive glue 14 was applied by the ellipse form or the ellipse at the corner of one vertical angle of a diaphragm 1 may be crossed. Since the elastic support material 13 is rising to Yamagata, electroconductive glue 14 bypasses the shortest path which connects a diaphragm 1 and the internal connection sections 11a and 12a, and is applied. Under the present circumstances, it is necessary to warn against

adhering to the part to which electroconductive glue 14 is a clearance between a diaphragm 1 and the internal connection sections 11a and 12a, and the elastic support material 13 is not applied. As electroconductive glue 14, the urethane system conductive paste of 0.3×10^9 Pa is used, for example for the Young's modulus after hardening. After applying electroconductive glue 14, heat hardening of this is carried out.

[0023] Between the perimeter of a diaphragm 1, and the inner circumference section of a case 10, it is closed with the elastic sealing agent (the 2nd adhesives) 15, and the air leak between the side front of a diaphragm 1 and a background is prevented. Heat hardening is carried out after applying the elastic sealing agent 15 annularly. In this example, the Young's modulus for example, after hardening is using the silicone system adhesives of 3.0×10^5 Pa as an elastic sealing agent 15.

[0024] After fixing a diaphragm 1 to a case 10 as mentioned above, a cover plate 20 pastes top-face opening of a case 10 with adhesives 21. A cover plate 20 is formed with the same ingredient as a case 10. By pasting up a cover plate 20, sound space is formed between a cover plate 20 and a diaphragm 1. The piezo-electric mold electroacoustic transducer of a surface mount mold is completed as mentioned above.

[0025] If a predetermined alternation signal (an AC signal or square wave signal) is impressed between the terminal 11 prepared in the above-mentioned case 10, and 12, since four sides of a diaphragm 1 are being fixed to 10g of supporters of a case 10, a diaphragm 1 can vibrate in area crookedness mode, and can generate a predetermined sound. The generated sound is emitted to the exterior from the sound emission hole formed between a cover plate 20 and 10l. of notches of a case 10.

[0026] Although the metal plate 3 of a diaphragm 1 was turned to the bottom wall section 10a side of a case 10 and it fixed in the above-mentioned explanation, the piezo-electric plate 2 may be turned to the bottom wall section 10a side of a case 10, and you may fix. Since surface electrode 2a of the piezo-electric plate 2

and outcrop 3a of a metal plate 3 are exposed to an upside when a metal plate 3 is turned to the bottom wall section 10a side and it fixes, connection between outcrop 3a and a terminal 11 and connection between surface electrode 2a and a terminal 12 can be easily made using electroconductive glue 14. In addition, since it has the role which prevents that the elastic support material 13 enters the clearance between a diaphragm 1 and a case 10 as mentioned above, and electroconductive glue 14 adheres to a metal plate 3 although it becomes a faulty connection when connecting surface electrode 2a and a terminal 12, and electroconductive glue 14 adheres to a metal plate 3, a faulty connection can be prevented certainly.

[0027] Drawing 6 - drawing 11 show the piezo-electric mold electroacoustic transducer which is the 2nd operation gestalt of this invention. The electroacoustic transducer of this operation gestalt is used for the application corresponding to the frequency of a large range like a piezo-electric earphone. This electroacoustic transducer consists of a profile, and the diaphragm 30, the case 10 and cover plate 20 of a laminated structure. Except for a case 10 and a diaphragm 30, other configurations are almost the same as that of the 1st operation gestalt shown in drawing 1 - drawing 5 , give the same sign to the same part, and omit duplication explanation.

[0028] The point that this case 10 differs from the case 10 in the 1st operation gestalt The point currently formed only in the inside which are two side attachment walls 10b and 10d with which 10g of supporters counters as shown in drawing 8 , As shown in drawing 9 , it is the inside of other two side-attachment-wall sections 10c and 10e, and they are the point that 10h of slots for elastic sealing agent flow stops is formed in the location lower than 10g of supporters, and the point that the sound emission hole 23 is formed in the cover plate 20.

[0029] As shown in drawing 10 and drawing 11 , as for a diaphragm 30, the laminating of the two-layer electrostrictive ceramics layers 31 and 32 is carried out, the principal plane electrodes 33 and 34 are formed in the front flesh-side principal plane of a diaphragm 30, and the internal electrode 35 is formed among

the ceramic layers 31 and 32. As a thick wire arrow head shows to drawing 11 , in the thickness direction, polarization of the two ceramic layers 31 and 32 is carried out in the same direction. The principal plane electrode 33 on a side front and the principal plane electrode 34 on a background are formed a little shorter than the side length of a diaphragm 30, and the end is connected to the end-face electrode 36 formed in one end face of a diaphragm 30. Therefore, the principal plane electrodes 33 and 34 of a front flesh side are connected mutually. The internal electrode 35 was mostly formed in the symmetry configuration with the principal plane electrodes 33 and 34, it is separated from the end of an internal electrode 35 of the internal electrode with the above-mentioned end-face electrode 36, and the other end is connected to the end-face electrode 37 formed in the other end side of a diaphragm 30. In addition, the end-face electrode 37 and the flowing auxiliary electrode 38 are formed in the table rear face of the other end of a diaphragm 30.

[0030] The wrap resin layer 39 is formed in the table rear face of a diaphragm 30 in the principal plane electrodes 33 and 34. Since the diaphragm 30 consists of only ceramic ingredients, this resin layer 39 is formed in order to raise shatter strength. And notch 39a which the principal plane electrodes 33 and 34 expose near the corner of the vertical angle of a diaphragm 30, and notch 39b which an auxiliary electrode 38 exposes are formed in the resin layer 39 of a front flesh side. In addition, although Notches 39a and 39b may be formed only in front flesh-side one side, in order to abolish the directivity of a front flesh side, in this example, it has prepared in the table rear face. Moreover, it is not necessary to use an auxiliary electrode 38 as the band electrode of constant width, and only the part corresponding to notch 39b may be established. Here, the 10mmx10mmx20micrometer PZT system ceramics was used as ceramic layers 31 and 32, and the polyamidoimide system resin whose thickness is 5-10 micrometers as a resin layer 39 was used.

[0031] The above-mentioned diaphragm 30 is contained by the case 10, and is fixed to 10g of supporters of a case 10 by the elastic support material 13 by four

places. The elastic support material 13 is applied to an oblong ellipse form between the principal plane electrodes 33 and internal connection section 11a of a terminal 11 which are exposed to notch 39a in a diagonal location, and between the auxiliary electrodes 38 and internal connection section 12a of a terminal 12 which are exposed to notch 39b. Moreover, the elastic support material 13 is applied to an oblong ellipse form also about the two remaining places. Heat hardening of the elastic support material 13 is carried out after spreading. In addition, as the fixed approach of a diaphragm 30, after containing a diaphragm 30 in a case 10, the elastic support material 13 may be applied by a dispenser etc., but where the elastic support material 13 is beforehand applied to a diaphragm 30, a diaphragm 30 may be held in a case 10.

[0032] After stiffening the elastic support material 13, it applies to an ellipse form so that the elastic support material 13 top to which electroconductive glue 14 was applied by the ellipse form may be crossed, and the principal plane electrode 33, internal connection section 11a of a terminal 11 and an auxiliary electrode 38, and internal connection section 12a of a terminal 12 are connected, respectively. That is, electroconductive glue 14 bypasses the shortest path which connects a diaphragm 30 and the internal connection sections 11a and 12a, and is applied. Heat hardening is carried out after applying electroconductive glue 14.

[0033] After applying and stiffening electroconductive glue 14, the elastic sealing agent 15 is applied to the clearance between a diaphragm 30 and the inner circumference section of a case 10, and between both is closed. Since the elastic sealing agent 15 is caught at 10h of slots formed inside the two side-attachment-wall sections 10c and 10e at this time as shown in drawing 9 R> 9, to bottom wall section 10a, the elastic sealing agent 15 flows and does not fall. Therefore, between a diaphragm 30 and cases 10 is closed certainly.

[0034] With the electroacoustic transducer of this operation gestalt, the crookedness oscillation of the diaphragm 30 can be carried out by impressing a predetermined alternation electrical potential difference between a terminal 11 and 12. Since the electrostrictive ceramics layer the direction of polarization and

whose direction of electric field are the same directions is shrunken in the direction of a flat surface and the electrostrictive ceramics layer the direction of polarization and whose direction of electric field are hard flow is extended in the direction of a flat surface, it is crooked in the thickness direction as a whole. In the case of this operation gestalt, a diaphragm 30 is the laminating structure of the ceramics which does not have a metal plate, and since two oscillating fields arranged in order in the thickness direction vibrate to hard flow mutually, compared with a uni-morph mold diaphragm, the big amount of displacement, i.e., big sound pressure, can be obtained.

[0035] With the 2nd operation gestalt, although the supporter was formed in the two-side overall length of a case, supporter 10i may be prepared in four corners like the case 10 shown in drawing 12 . In this case, four corners of a diaphragm 30 are fixed to supporter 10i by the elastic support material 13. Thus, by supporting only the corner of a diaphragm 30, resonance frequency can be lowered and the sound pressure of a low frequency region can be raised. In addition, in drawing 6 R> 6 and drawing 12 , 10f of level difference sections and 10h (refer to drawing 9) of slots of slight width prepared inside the side-attachment-wall sections 10c and 10e were omitted.

[0036] This invention is not limited to the above-mentioned operation gestalt, and can be changed in the range which does not deviate from the meaning of this invention. For example, although a diaphragm 30 carries out the laminating of the two-layer electrostrictive ceramics layer, what carried out the laminating of the three or more-layer electrostrictive ceramics layer may be used. Moreover, diaphragms 1 and 30 may be any of a square and a rectangle. Although the 1st operation gestalt explained the uni-morph mold diaphragm which stuck the piezo-electric plate on one side of a metal plate, the bimorph form diaphragm which stuck the piezo-electric plate on both sides of a metal plate may be used. Although it set up with the above-mentioned operation gestalt so that the diaphragm and the internal connection section which made the supporter of a case lower one step than the internal connection section of a terminal electrode,

and were supported by the supporter of a case might become the same height mostly, the supporter and the internal connection section of a case may be made into the same height, and a diaphragm may be fixed on it. The terminal electrode in this invention may be an electrode of the thin film from the supporter top face of a case to [does not restrict to an insertion terminal like the above-mentioned operation gestalt, and] outside for example, or a thick film. The same ingredient may be used although the ingredient which is hard to permeate from the 2nd adhesives as the 1st adhesives (elastic support material) was used with the above-mentioned operation gestalt. The spreading location of the 1st adhesives may cover the overall length of two sides which what [not only] was selectively applied near [four] the corner of a diaphragm but a diaphragm counters, and may be applied continuously. Moreover, as long as the spreading location of electroconductive glue is for pulling out the electrode of not only two places of the vertical angle of a diaphragm but a diaphragm outside, what kind of location is sufficient as it. The case of this invention is not restricted to what consisted of a case of a concave cross-section configuration like an operation gestalt, and a cover plate adhered to the top face.

[0037]

[Effect of the Invention] After fixing the between the periphery section of a diaphragm, and near the supporter of a case with the 1st adhesives by the above explanation according to invention according to claim 1 so that clearly, In case between the internal connection sections of the electrode of a piezo-electric diaphragm and a terminal electrode is electrically connected with electroconductive glue, electroconductive glue bypasses the shortest path which connects a piezo-electric diaphragm and the internal connection section through the top face of the 1st adhesives, and since it applies and hardens It is eased by the 1st adhesives and the direct action of the hardening contraction stress of electroconductive glue is not carried out to a piezo-electric diaphragm. therefore - - thin -- even if it is a **** piezo-electric diaphragm, distortion does not occur, and frequency characteristics do not vary Moreover, since the 1st adhesives mitigate

stress also when external force joins the time of surrounding temperature changing, and a case, stress hardly affects a piezo-electric diaphragm, but it has the operation effectiveness that it can prevent that frequency characteristics change.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the decomposition perspective view of the 1st operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 2] It is a top view in the condition of having excepted the cover plate and the 2nd adhesives of a piezo-electric mold electroacoustic transducer which are shown in drawing 1 .

[Drawing 3] It is a stairway sectional view by the A-A line of drawing 2 .

[Drawing 4] It is the B-B line sectional view of drawing 2 .

[Drawing 5] It is the perspective view of the piezo-electric diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 1 .

[Drawing 6] It is the decomposition perspective view of the 2nd operation gestalt of the piezo-electric mold electroacoustic transducer concerning this invention.

[Drawing 7] It is a top view in the condition of having excepted the cover plate and the 2nd adhesives of a piezo-electric mold electroacoustic transducer which are shown in drawing 6 .

[Drawing 8] It is a stairway sectional view by the C-C line of drawing 7 .

[Drawing 9] It is D-D line sectional view of drawing 7 .

[Drawing 10] It is the perspective view of the piezo-electric diaphragm used for the piezo-electric mold electroacoustic transducer of drawing 6 .

[Drawing 11] It is a stairway sectional view by the E-E line of drawing 10 .

[Drawing 12] It is the perspective view of the modification of a case.

[Description of Notations]

1 30 Piezo-electric diaphragm

10 Case

10g Supporter

11 12 Terminal (terminal electrode)

11a, 12a Internal connection section

11b, 12b External connection

13 Elastic Support Material (1st Adhesives)

14 Electroconductive Glue

15 Elastic Sealing Agent (2nd Adhesives)

20 Cover Plate

[Translation done.]

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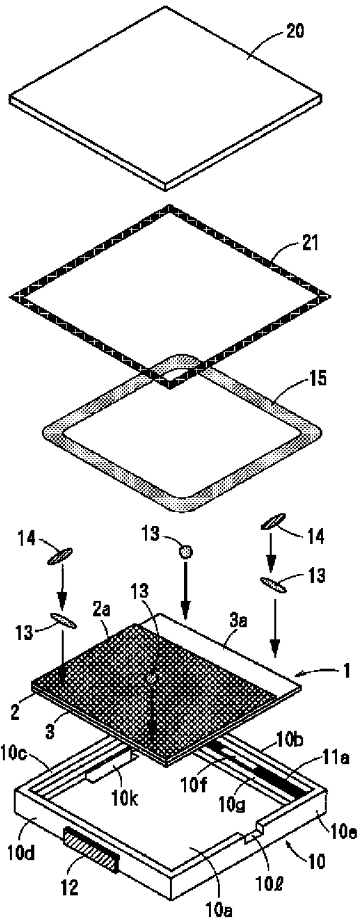
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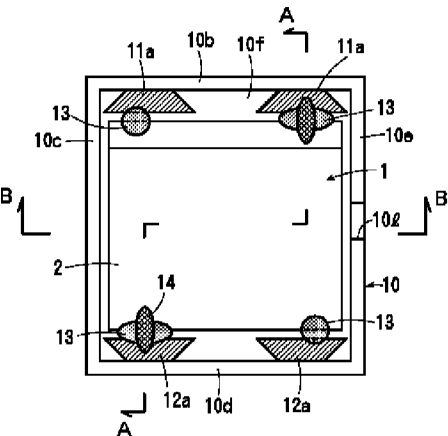
DRAWINGS

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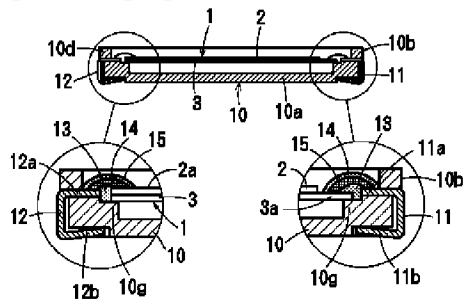
[Drawing 1]



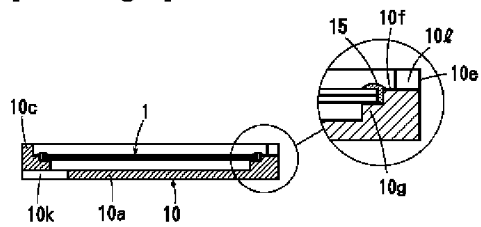
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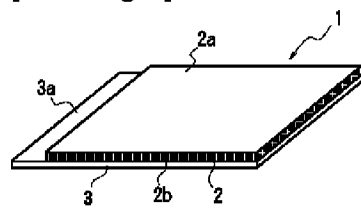
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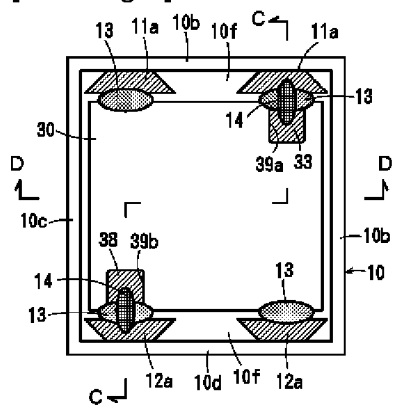
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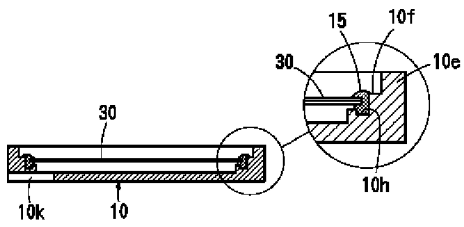
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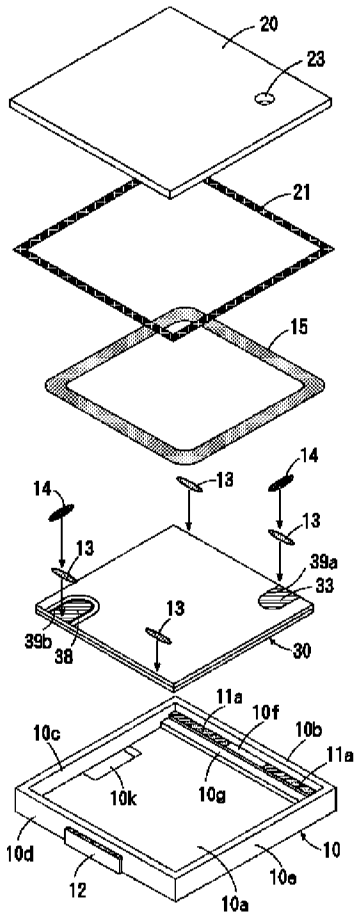
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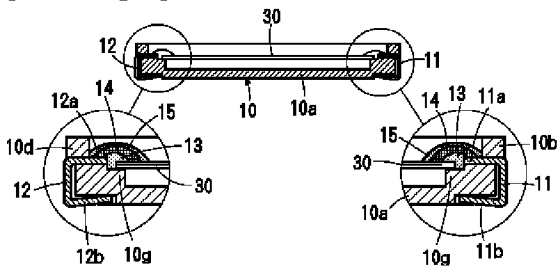
[Drawing 9]



[Drawing 6]



[Drawing 8]



[Drawing 10]

(19)日本国特許庁 (J P)

(12) 公 開 特 許 公 報 (A)

(11)特許出願公開番号

特開2003-9286

(P2003-9286A)

(43)公開日 平成15年1月10日(2003.1.10)

(51)Int.Cl.⁷

識別記号

F I

テ-マ-ト*(参考)

H 0 4 R 17/00

H 0 4 R 17/00

5 D 0 0 4

審査請求 未請求 請求項の数8 O L (全 8 頁)

(21)出願番号 特願2001-193305(P2001-193305)

(22)出願日 平成13年6月26日(2001.6.26)

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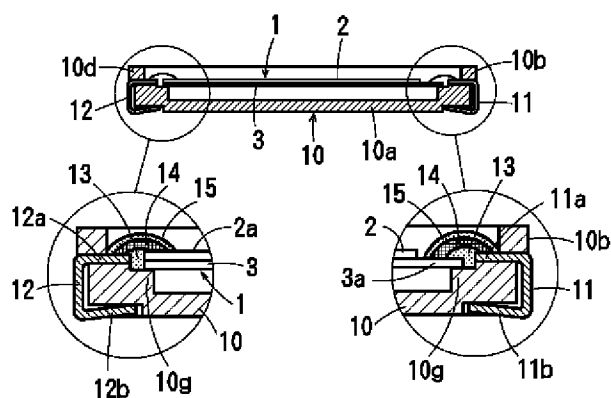
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(54)【発明の名称】 圧電型電気音響変換器およびその製造方法

(57)【要約】 (修正有)

【課題】薄肉な振動板をケースに固定する接着剤および電気的接続を行う導電性接着剤の塗布位置を工夫することで、振動板の歪みを防止し、周波数特性の安定した圧電型電気音響変換器を提供する。

【解決手段】電極間に交番信号を印加することにより板厚方向に屈曲振動する四角形の圧電振動板1の外周部と端子の内部接続部11a、12aとの間であって、圧電振動板1と内部接続部とを結ぶ最短経路に塗布され、圧電振動板をケースに対して固定する第1の接着剤13と、圧電振動板の電極と端子の内部接続部との間に、第1の接着剤13の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して塗布され、圧電振動板の電極と端子の内部接続部との間を電気的に接続する導電性接着剤14と、圧電振動板の外周部とケースの内周部との隙間を封止する第2の接着剤15とを備える。



【特許請求の範囲】

【請求項1】電極間に交番信号を印加することにより板厚方向に屈曲振動する四角形の圧電振動板と、側壁部の内側に圧電振動板を支持する支持部を持つ四角形の絶縁性ケースと、上記支持部近傍に内部接続部が露出し、この内部接続部と導通する外部接続部がケースの外面に露出した端子電極と、圧電振動板の外周部と内部接続部との間であって、圧電振動板と内部接続部とを結ぶ最短経路に塗布され、圧電振動板をケースに対して固定する第1の接着剤と、圧電振動板の電極と端子電極の内部接続部との間に、第1の接着剤の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して塗布され、圧電振動板の電極と端子電極の内部接続部とを電気的に接続する導電性接着剤と、圧電振動板の外周部とケースの内周部との隙間を封止する第2の接着剤とを備え、上記第1および第2の接着剤は導電性接着剤より硬化状態でのヤング率が小さいことを特徴とする圧電型電気音響変換器。

【請求項2】上記第1の接着剤は第2の接着剤に比べて、未硬化状態での粘性が高く、滲みにくい性質を有することを特徴とする請求項1に記載の圧電型電気音響変換器。

【請求項3】上記第1の接着剤は、圧電振動板の4つの角部近傍に部分的に塗布されていることを特徴とする請求項1または2に記載の圧電型電気音響変換器。

【請求項4】上記導電性接着剤は、圧電振動板の4つの角部近傍のうち、少なくとも2箇所に塗布されていることを特徴とする請求項3に記載の圧電型電気音響変換器。

【請求項5】電極間に交番信号を印加することにより板厚方向に屈曲振動する四角形の圧電振動板を準備する工程と、側壁部の内側に、圧電振動板を支持する支持部を持ち、上記支持部近傍に内部接続部が露出し、この内部接続部と導通する外部接続部が外部に露出した端子電極を持つ四角形の絶縁性ケースを準備する工程と、圧電振動板の外周部と内部接続部との間であって、圧電振動板と内部接続部とを結ぶ最短経路に第1の接着剤を塗布し硬化させて、圧電振動板をケースに対して固定する工程と、圧電振動板の電極と端子電極の内部接続部との間に、第1の接着剤の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して導電性接着剤を塗布し硬化させて、圧電振動板の電極と端子電極の内部接続部とを電気的に接続する工程と、圧電振動板の外周部とケースの内周部との隙間に第2の接着剤を塗布し硬化させて、両者の間を封止する工程とを備え、上記第1および第2の接着剤は導電性接着剤より硬化状態でのヤング率が小さいことを特徴とする圧電型電気音響変換器の製造方法。

【請求項6】上記第1の接着剤は第2の接着剤に比べて、未硬化状態での粘性が高く、滲みにくい性質を有す

ることを特徴とする請求項5に記載の圧電型電気音響変換器の製造方法。

【請求項7】上記第1の接着剤は、圧電振動板の4つの角部近傍に部分的に塗布されることを特徴とする請求項5または6に記載の圧電型電気音響変換器の製造方法。

【請求項8】上記導電性接着剤は、圧電振動板の4つの角部近傍のうち、少なくとも2箇所に塗布されることを特徴とする請求項7に記載の圧電型電気音響変換器。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は圧電ブザーや圧電受話器などの圧電型電気音響変換器およびその製造方法に関するものである。

【0002】

【従来の技術】従来、電子機器、家電製品、携帯電話機などにおいて、警報音や動作音を発生する圧電ブザーあるいは圧電受話器として圧電型電気音響変換器が広く用いられている。この種の圧電型電気音響変換器は、円形の金属板の片面に円形の圧電素子を貼り付けてユニモルフ型振動板を構成し、金属板の周縁部を円形のケースの中にシリコンゴムを用いて支持するとともに、ケースの開口部をカバーで閉鎖した構造のものが一般的である。しかしながら、円形の振動板を用いると、生産効率が悪く、音響変換効率が低く、しかも小型に構成することが難しいという問題点があった。

【0003】そこで、四角形の振動板を用いることで、生産効率の向上、音響変換効率の向上および小型化を可能とした圧電型電気音響変換器が提案されている(特開2000-310990号)。この圧電型電気音響変換器は、四角形の圧電振動板と、底壁部と4つの側壁部とを有し、対向する2つの側壁部の内側に振動板を支持する支持部を持ち、支持部に外部接続用の第1と第2の導電部が設けられた絶縁性ケースと、放音孔を有する蓋板とを備え、ケース内に振動板が収納され、振動板の対向する2辺と支持部とが接着剤または弾性封止材で固定されるとともに、振動板の残りの2辺とケースとの隙間が弾性封止材で封止され、振動板と第1、第2の導電部とが導電性接着剤により電気的に接続され、ケースの側壁部開口端に蓋板が接着された構造となっている。

【0004】

【発明が解決しようとする課題】近年、圧電型電気音響変換器に使用される振動板は非常に薄くなり、数十～百 μm 程度の薄肉な振動板が使用されている。このような薄肉な振動板を用いた場合には、その支持構造が周波数特性に与える影響が大きくなる。例えば振動板と外部電極との間を、ウレタン系などの熱硬化型の導電性接着剤で直接接続すると、導電性接着剤の硬化収縮応力により振動板に歪みが発生し、周波数特性がばらつく。また、周囲の温度が変化すると、ケースと振動板との熱膨張係数差により特性が変化したり、ケースに外力が加わった

時に振動板にも直接力が伝達され、特性が変化することがある。

【0005】上記のように弾性支持材で振動板とケースとを固定した後、その上に導電性接着剤を塗布しても、導電性接着剤が振動板の対向する2辺とケースの支持部、つまり、外部電極に導通する内部接続部との間を結ぶ最短経路に塗布されていると、導電性接着剤の硬化収縮によって発生する応力が振動板に作用し、周波数特性がばらつくなどの問題が発生することがある。

【0006】そこで、本発明の目的は、振動板をケースに固定する接着剤および電氣的接続を行う導電性接着剤の塗布位置を工夫することで、振動板の歪みを防止し、周波数特性の安定した圧電型電気音響変換器およびその製造方法を提供することにある。

【0007】

【課題を解決するための手段】上記目的を達成するため、請求項1に係る発明は、電極間に交番信号を印加することにより板厚方向に屈曲振動する四角形の圧電振動板と、側壁部の内側に圧電振動板を支持する支持部を持つ四角形の絶縁性ケースと、上記支持部近傍に内部接続部が露出し、この内部接続部と導通する外部接続部がケースの外面に露出した端子電極と、圧電振動板の外周部と内部接続部との間であって、圧電振動板と内部接続部とを結ぶ最短経路に塗布され、圧電振動板をケースに対して固定する第1の接着剤と、圧電振動板の電極と端子電極の内部接続部との間に、第1の接着剤の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して塗布され、圧電振動板の電極と端子電極の内部接続部とを電氣的に接続する導電性接着剤と、圧電振動板の外周部とケースの内周部との隙間を封止する第2の接着剤とを備え、上記第1および第2の接着剤は導電性接着剤より硬化状態でのヤング率が小さいことを特徴とする圧電型電気音響変換器を提供する。

【0008】請求項5に係る発明は、電極間に交番信号を印加することにより板厚方向に屈曲振動する四角形の圧電振動板を準備する工程と、側壁部の内側に、圧電振動板を支持する支持部を持ち、上記支持部近傍に内部接続部が露出し、この内部接続部と導通する外部接続部が外部に露出した端子電極を持つ四角形の絶縁性ケースを準備する工程と、圧電振動板の外周部と内部接続部との間であって、圧電振動板と内部接続部とを結ぶ最短経路に第1の接着剤を塗布し硬化させて、圧電振動板をケースに対して固定する工程と、圧電振動板の電極と端子電極の内部接続部との間に、第1の接着剤の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して導電性接着剤を塗布し硬化させて、圧電振動板の電極と端子電極の内部接続部とを電氣的に接続する工程と、圧電振動板の外周部とケースの内周部との隙間に第2の接着剤を塗布し硬化させて、両者の間を封止する工程とを備え、上記第1および第2の接着剤は導電性接着

剤より硬化状態でのヤング率が小さいことを特徴とする圧電型電気音響変換器の製造方法を提供する。

【0009】本発明では、振動板の外周部と端子電極の内部接続部との間を第1の接着剤で固定した後、導電性接着剤によって圧電振動板の電極と端子電極の内部接続部との間を電氣的に接続する。このとき、第1の接着剤は圧電振動板の外周部と内部接続部との間であって、圧電振動板と内部接続部とを結ぶ最短経路に塗布、硬化され、導電性接着剤は第1の接着剤の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して塗布、硬化される。第1の接着剤は導電性接着剤より硬化状態でのヤング率が小さいので、導電性接着剤の硬化収縮によって発生する応力は第1の接着剤によって緩和され、圧電振動板に直接作用しない。そのため、圧電振動板の歪みが発生せず、周波数特性がばらつくことがない。また、周囲の温度が変化した時やケースに外力が加わった時も、第1の接着剤が応力を緩和するので、圧電振動板には殆ど応力が波及せず、周波数特性が変化するのを防止できる。

【0010】本発明の圧電型電気音響変換器を製造するに際し、圧電振動板をケースに収納した後、第1の接着剤を塗布してもよいし、圧電振動板をケースに収納する前に圧電振動板の外周部またはケースの支持部近傍に第1の接着剤を塗布してもよい。前者の場合には、ディスペンサを用いて第1の接着剤が塗布されるが、後者の場合は、ディスペンサを用いる方法に限らず、コテなどを用いて圧電振動板の端部に第1の接着剤を塗布し、この圧電振動板をケースに収納することにより、接着固定してもよい。

【0011】請求項2のように、第1の接着剤は第2の接着剤に比べて、未硬化状態での粘性が高く、滲みにくい性質を有するものが望ましい。すなわち、第1の接着剤が未硬化状態での粘性が低く、滲みやすい場合には、第1の接着剤が圧電振動板の電極や端子電極の内部接続部を塞いでしまい、導電性接着剤を塗布するとき、圧電振動板の電極や端子電極の内部接続部と導通させることが困難になることがある。また、圧電振動板の外周部と内部接続部とを結ぶ最短経路部分に第1の接着剤がとどまらないこともある。そこで、滲みにくい性質の第1の接着剤を用いることで、このような問題を解消し、圧電振動板と端子電極とを導電性接着剤により確実に最短経路を迂回して接続することができる。

【0012】請求項3のように、第1の接着剤を圧電振動板の4つの角部近傍に部分的に塗布するのがよい。第1の接着剤として、加熱硬化型の接着剤を使用した場合、ケースの4辺の中央部ほど変形が大きくなり、圧電振動板への応力も、4辺の中央部に応力が大きく作用する。これに対し、第1の接着剤を圧電振動板の4つの角部近傍に部分的に塗布すれば、第1の接着剤の硬化時にケースの変形が小さいため、圧電振動板への影響が少な

くて済む。

【0013】請求項4のように、導電性接着剤は、圧電振動板の4つの角部近傍のうち、少なくとも2箇所に塗布してもよい。請求項3のように第1の接着剤を圧電振動板の4つの角部近傍に部分的に塗布すれば、圧電振動板の歪みの発生を抑制できるが、さらに請求項4のように導電性接着剤を第1の接着剤のうちの少なくとも2箇所に塗布することで、導電性接着剤の硬化収縮により発生する応力による歪みの影響を一層少なくできる。

【0014】振動板はその支持方法により、長さベンディングモードで屈曲振動する場合と、面積屈曲モードで屈曲振動する場合とがある。前者は、長さ方向両端部を支点として板厚方向に屈曲振動するモードである。後者は4辺または4点を支点として振動板の主面をなす2つの対角線位置が最大変位となるように、つまり対角線の交点が最大変位量となるように振動板の面積全体が厚み方向に屈曲振動するモードである。

【0015】本発明において、導電性接着剤としてはウレタン系の導電ペーストが望ましい。第1の接着剤としては、硬化状態におけるヤング率が導電性接着剤より低いものが使用され、例えばウレタン系接着剤を使用できる。第2の接着剤としては、第1の接着剤よりさらにヤング率が低く、硬化収縮応力も低いものがよく、例えばシリコン系接着剤を使用することができる。なお、第1、第2の接着剤として常温硬化型の接着剤を使用することも可能であるが、ディスペンサなどで塗布する際、塗布の途中で硬化を開始するので、ディスペンサに詰まりが発生しやすく、作業性が悪い。これに対し、熱硬化型の接着剤であれば、常温では粘度が一定しているので、塗布の途中で粘度が変化せず、ディスペンサに詰まりが発生せず、作業性が良いという利点がある。

【0016】

【発明の実施の形態】図1～図5は本発明の第1の実施形態である表面実装型の圧電型電気音響変換器を示す。この電気音響変換器は、サウндаやリングなどのように単一周波数で用いられる用途に適したものであり、大略、ユニモルフ型の振動板1とケース10と蓋板20とで構成されている。

【0017】振動板1は、図5に示すように、表裏面に薄膜または厚膜の電極2a、2bを有し、厚み方向に分極された4角形の圧電板2と、圧電板2と幅寸法が同一で長さ寸法がやや長い四角形に形成され、圧電板2の裏面電極2bに導電性接着剤などを介して対面接着された金属板3とで構成されている。なお、裏面電極2bを省略し、金属板3を圧電板2の裏面に導電性接着剤などを介して直接接合することで、裏面電極2bを省略してもよい。この実施例では、圧電板2が金属板3に対して長さ方向の一辺側へ偏った位置に接着されており、金属板3の長さ方向の他辺側には金属板3が露出した露出部3aを有する。

【0018】圧電板2としては、例えばPZTなどの圧電セラミックスが用いられる。また、金属板3は良導電性とバネ弾性とを兼ね備えた材料が望ましく、例えばリン青銅、42Niなどのヤング率が圧電板2と近い材料が望ましい。ここでは、金属板3として、セラミック(PZT等)と熱膨張係数が近く、縦×横×厚みが10mm×10mm×0.05mmの42Ni製金属板を使用した。また、圧電板2として縦×横×厚みが8mm×10mm×0.05mmのPZT板を用いた。

【0019】ケース10はセラミックスまたは樹脂などの絶縁性材料で底壁部10aと4つの側壁部10b～10eとを持つ4角形の箱型に形成されている。ケース10を樹脂で構成する場合には、LCP(液晶ポリマー)、SPS(シンジオタクチックポリスチレン)、PPS(ポリフェニレンサルファイド)、エポキシなどの耐熱樹脂が望ましい。4つの側壁部10b～10eの内周には環状の段差部10fが設けられ、対向する2つの側壁部10b、10dの内側の段差部10f上に、端子電極である一対の端子11、12の内部接続部11a、12aが露出している。端子11、12はケース10にインサート成形されたものであり、ケース10の外部に突出した外部接続部11b、12bが側壁部10b、10dの外面に沿ってケース10の底面側へ折り曲げられている。この実施例では、端子11、12の内部接続部11a、12aが二股状に別れており、これら二股状の内部接続部11a、12aが段差部10fの両端部近傍に位置し、しかも内部接続部11a、12aは末広がりな逆三角形形状をなしている。

【0020】段差部10fの内側には、図3に示すように、振動板1の周辺部を支持するための環状の支持部10gが、段差部10fより一段低く形成されている。そのため、支持部10g上に振動板1を載置すると、振動板1の天面と端子11、12の内部接続部11a、12aの上面とがほぼ同一高さになる。なお、底壁部10aには第1の放音孔10kが形成され、側壁10eの上縁部には第2の放音孔となる切欠部10lが形成されている(図1、図4参照)。

【0021】上記振動板1は金属板3がケース10の底壁部10aを向くようにケース10内に収納され、4辺がケース10の支持部10g上に載置される。そして、振動板1の4つの角部近傍が弾性支持材(第1の接着剤)13によって接着固定される。すなわち、金属板3の露出部3aの両端部近傍と端子11の内部接続部11aとの間、つまり露出部3aと内部接続部11aとを結ぶ最短経路が弾性支持材13によって接着固定され、これと対向する辺の両端部近傍と端子12の内部接続部12aとの間が弾性支持材13によって接着固定される。この実施例では、振動板1の一方の対角の角部に塗布される弾性支持材13は振動板1の側辺に沿って横長の楕円形あるいは長円形であり、他方の対角の角部に塗布さ

れる弾性支持材13は円形の点滴状であるが、これに限るものではない。弾性支持材13としては、例えば硬化後のヤング率が 3.7×10^6 Paのウレタン系接着剤が使用される。また、この弾性支持材13の未硬化状態での粘性が後述する弾性封止材15より高く(例えば $50 \sim 120$ dPa·s)、滲みにくい性質を有するので、弾性支持材13を塗布したとき、弾性支持材13が山形に盛り上がる。弾性支持材13を塗布した後、加熱硬化させる。なお、振動板1の固定方法としては、振動板1をケース10に収納した後でディスペンサなどで弾性支持材13を塗布してもよいが、振動板1に予め弾性支持材13を塗布した状態で振動板1をケース10に収容してもよい。

【0022】弾性支持材13によってケース10に固定された振動板1と、端子11、12の内部接続部11a、12aとを導電性接着剤14によって電気的に接続する。すなわち、導電性接着剤14を振動板1の一方の対角の角部に楕円形あるいは長円形に塗布された弾性支持材13の上を交差するように楕円形に塗布する。弾性支持材13は山形に盛り上がっているため、導電性接着剤14は振動板1と内部接続部11a、12aとを結ぶ最短経路を迂回して塗布される。この際、導電性接着剤14が振動板1と内部接続部11a、12aとの隙間であって弾性支持材13が塗布されていない部位に付着しないように注意する必要がある。導電性接着剤14としては、例えば硬化後のヤング率が 0.3×10^9 Paのウレタン系導電ペーストが使用される。導電性接着剤14を塗布した後、これを加熱硬化させる。

【0023】振動板1の周囲全周とケース10の内周部との間は弾性封止材(第2の接着剤)15で封止され、振動板1の表側と裏側との間の空気漏れが防止される。弾性封止材15を環状に塗布した後、加熱硬化させる。この実施例では、弾性封止材15として、例えば硬化後のヤング率が 3.0×10^5 Paのシリコン系接着剤を使用している。

【0024】上記のように振動板1をケース10に固定した後、ケース10の上面開口部に蓋板20が接着剤21によって接着される。蓋板20はケース10と同様な材料で形成される。蓋板20を接着することで、蓋板20と振動板1との間に音響空間が形成される。上記のようにして表面実装型の圧電型電気音響変換器が完成する。

【0025】上記ケース10に設けられた端子11、12間に所定の交番信号(交流信号または矩形波信号)を印加すれば、振動板1の4辺がケース10の支持部10gに固定されているので、振動板1は面積屈曲モードで振動し、所定の音を発生することができる。発生した音は、蓋板20とケース10の切欠部101との間で形成される放音穴から外部へ放出される。

【0026】上記の説明では、振動板1の金属板3をケ

ース10の底壁部10a側に向けて固定したが、圧電板2をケース10の底壁部10a側に向けて固定してもよい。金属板3を底壁部10a側に向けて固定した場合には、圧電板2の表面電極2aと金属板3の露出部3aとが上側に露出するので、露出部3aと端子11との接続、および表面電極2aと端子12との接続を導電性接着剤14を用いて簡単に行なうことができる。なお、表面電極2aと端子12とを接続する場合に、導電性接着剤14が金属板3に付着すると接続不良になるが、上記のように弾性支持材13が振動板1とケース10との隙間に入り込み、導電性接着剤14が金属板3に付着するのを阻止する役割を持つので、接続不良を確実に防止できる。

【0027】図6～図11は本発明の第2の実施形態である圧電型電気音響変換器を示す。この実施形態の電気音響変換器は、圧電受話器のように広いレンジの周波数に対応する用途に使用される。この電気音響変換器は、大略、積層構造の振動板30とケース10と蓋板20とで構成されている。ケース10と振動板30とを除き、その他の構成は図1～図5に示された第1の実施形態とほぼ同一であり、同一部分には同一符号を付して重複説明を省略する。

【0028】このケース10が第1の実施形態におけるケース10と異なる点は、図8に示すように支持部10gが対向する2つの側壁10b、10dの内側にのみ形成されている点、図9に示すように他の2つの側壁部10c、10eの内側であって支持部10gより低い位置に弾性封止材流れ止め用溝部10hが形成されている点、蓋板20に放音孔23が形成されている点である。

【0029】振動板30は、図10、図11に示すように、2層の圧電セラミックス層31、32を積層したものであり、振動板30の表裏主面には主面電極33、34が形成され、セラミックス層31、32の間には内部電極35が形成されている。2つのセラミックス層31、32は、図11に太線矢印で示すように厚み方向において同一方向に分極されている。表側の主面電極33と裏側の主面電極34は、振動板30の辺長よりやや短く形成され、その一端は振動板30の一方の端面に形成された端面電極36に接続されている。そのため、表裏の主面電極33、34は相互に接続されている。内部電極35は主面電極33、34とほぼ対称形状に形成され、内部電極35の一端は上記端面電極36と離れており、他端は振動板30の他端面に形成された端面電極37に接続されている。なお、振動板30の他端部の表裏面には、端面電極37と導通する補助電極38が形成されている。

【0030】振動板30の表裏面には、主面電極33、34を覆う樹脂層39が形成されている。この樹脂層39は、振動板30がセラミック材料のみで構成されているため、落下強度を高めるために設けられている。そし

て、表裏の樹脂層39には、振動板30の対角の角部近傍に、主面電極33、34が露出する切欠部39aと、補助電極38が露出する切欠部39bとが形成されている。なお、切欠部39a、39bは表裏一方にのみ設けてもよいが、表裏の方向性をなくすため、この例では表裏面に設けてある。また、補助電極38は、一定幅の帯状電極とする必要はなく、切欠部39bに対応する箇所のみ設けてもよい。ここでは、セラミックス層31、32として10mm×10mm×20μmのPZT系セラミックスを使用し、樹脂層39として厚みが5〜10μmのポリアミドイミド系樹脂を使用した。

【0031】上記振動板30がケース10に収納され、4箇所弾性支持材13によってケース10の支持部10gに固定される。対角位置にある切欠部39aに露出する主面電極33と端子11の内部接続部11aとの間、および切欠部39bに露出する補助電極38と端子12の内部接続部12aとの間に、弾性支持材13が横長な楕円形に塗布される。また、残りの2箇所についても、弾性支持材13が横長な楕円形に塗布される。塗布後、弾性支持材13は加熱硬化される。なお、振動板30の固定方法として、振動板30をケース10に収納した後でディスペンサなどで弾性支持材13を塗布してもよいが、振動板30に予め弾性支持材13を塗布した状態で振動板30をケース10に収容してもよい。

【0032】弾性支持材13を硬化させた後、導電性接着剤14を楕円形に塗布された弾性支持材13の上を交差するように楕円形に塗布し、主面電極33と端子11の内部接続部11a、補助電極38と端子12の内部接続部12aとをそれぞれ接続する。つまり、導電性接着剤14は振動板30と内部接続部11a、12aとを結ぶ最短経路を迂回して塗布される。導電性接着剤14を塗布した後、加熱硬化させる。

【0033】導電性接着剤14を塗布、硬化させた後、弾性封止材15が振動板30とケース10の内周部との隙間に塗布され、両者の間が封止される。このとき、図9に示すように、2つの側壁部10c、10eの内側に形成された溝部10hで弾性封止材15が受け止められるので、弾性封止材15が底壁部10aまで流れ落ちることがない。そのため、振動板30とケース10との間が確実に封止される。

【0034】この実施形態の電気音響変換器では、端子11、12間に所定の交番電圧を印加することで、振動板30を屈曲振動させることができる。分極方向と電界方向とが同一方向である圧電セラミックス層は平面方向に縮み、分極方向と電界方向とが逆方向である圧電セラミックス層は平面方向に伸びるので、全体として厚み方向に屈曲する。この実施形態の場合には、振動板30が金属板を有しないセラミックスの積層構造体であり、厚み方向に順に配置された2つの振動領域が相互に逆方向に振動するので、ユニモルフ型振動板に比べて大きな変

位量、つまり大きな音圧を得ることができる。

【0035】第2の実施形態では、ケースの2辺全長に支持部を設けたが、図12に示すケース10のように、4隅部に支持部10iを設けてもよい。この場合には、振動板30の4つの角部が支持部10iに弾性支持材13によって固定される。このように振動板30の角部のみを支持することにより、共振周波数を下げることができ、低周波域の音圧を上げることができる。なお、図6、図12では、側壁部10c、10eの内側に設けられるわずかな巾の段差部10fおよび溝部10h(図9参照)を省略した。

【0036】本発明は上記実施形態に限定されるものではなく、本発明の趣旨を逸脱しない範囲で変更可能である。例えば、振動板30は2層の圧電セラミックス層を積層したものであるが、3層以上の圧電セラミックス層を積層したものでもよい。また、振動板1、30は正方形、長方形のいずれであってもよい。第1の実施形態では、金属板の片面に圧電板を貼り付けたユニモルフ型振動板について説明したが、金属板の両面に圧電板を貼り付けたバイモルフ型振動板を使用してもよい。上記実施形態では、ケースの支持部を端子電極の内部接続部より一段低くし、ケースの支持部に支持された振動板と内部接続部とがほぼ同一高さになるように設定したが、ケースの支持部と内部接続部とを同一高さとし、その上に振動板を固定してもよい。本発明における端子電極とは、上記実施形態のようなインサート端子に限るものではなく、例えばケースの支持部上面から外部に至る薄膜あるいは厚膜の電極であってもよい。上記実施形態では、第1の接着剤(弾性支持材)として第2の接着剤より浸みにくい材料を使用した。同一材料を用いてもよい。第1の接着剤の塗布位置は、振動板の4つの角部付近に部分的に塗布したものに限らず、振動板の対向する2辺の全長に亘って連続的に塗布してもよい。また、導電性接着剤の塗布位置は、振動板の対角の2箇所に限らず、振動板の電極を外部に引き出すためであれば、如何なる位置でもよい。本発明のケースは、実施形態のような凹断面形状のケースと、その上面に接着される蓋板とで構成されたものに限らない。

【0037】

【発明の効果】以上の説明で明らかなように、請求項1に記載の発明によれば、振動板の外周部とケースの支持部近傍との間を第1の接着剤で固定した後、導電性接着剤によって圧電振動板の電極と端子電極の内部接続部との間を電氣的に接続する際、導電性接着剤は第1の接着剤の上面を介して、かつ圧電振動板と内部接続部とを結ぶ最短経路を迂回して塗布、硬化されるので、導電性接着剤の硬化収縮応力は第1の接着剤によって緩和され、圧電振動板に直接作用しない。そのため、薄肉な圧電振動板であっても歪みが発生せず、周波数特性がばらつくことがない。また、周囲の温度が変化した時やケースに

外力が加わった時も、第1の接着剤が応力を緩和するので、圧電振動板には殆ど応力が波及せず、周波数特性が変化することを防止できるという作用効果を有する。

【図面の簡単な説明】

【図1】本発明に係る圧電型電気音響変換器の第1実施形態の分解斜視図である。

【図2】図1に示す圧電型電気音響変換器の蓋板および第2の接着剤を除外した状態の平面図である。

【図3】図2のA-A線による階段断面図である。

【図4】図2のB-B線断面図である。

【図5】図1の圧電型電気音響変換器に用いられる圧電振動板の斜視図である。

【図6】本発明に係る圧電型電気音響変換器の第2実施形態の分解斜視図である。

【図7】図6に示す圧電型電気音響変換器の蓋板および第2の接着剤を除外した状態の平面図である。

【図8】図7のC-C線による階段断面図である。

【図9】図7のD-D線断面図である。

【図10】図6の圧電型電気音響変換器に用いられる圧電振動板の斜視図である。

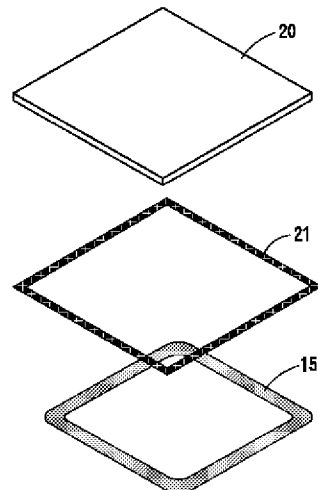
【図11】図10のE-E線による階段断面図である。

【図12】ケースの変形例の斜視図である。

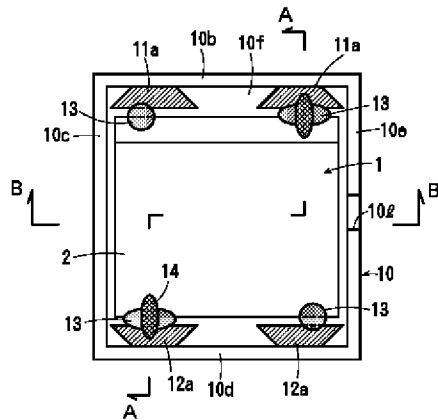
【符号の説明】

1, 30	圧電振動板
10	ケース
10g	支持部
11, 12	端子(端子電極)
11a, 12a	内部接続部
11b, 12b	外部接続部
13	弾性支持材(第1の接着剤)
14	導電性接着剤
15	弾性封止材(第2の接着剤)
20	蓋板

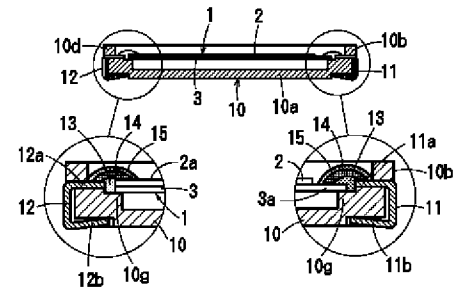
【図1】



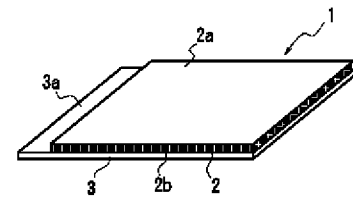
【図2】



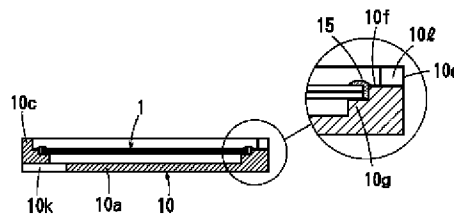
【図3】



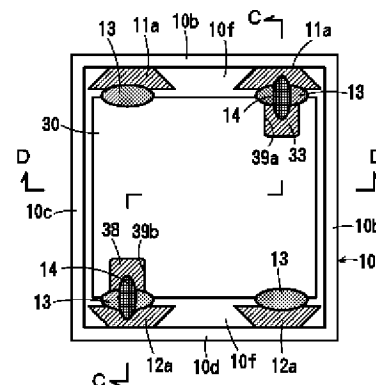
【図5】



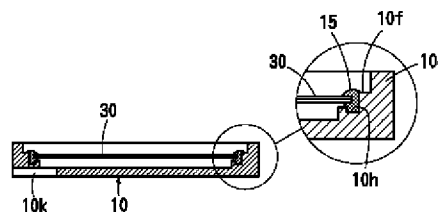
【図4】



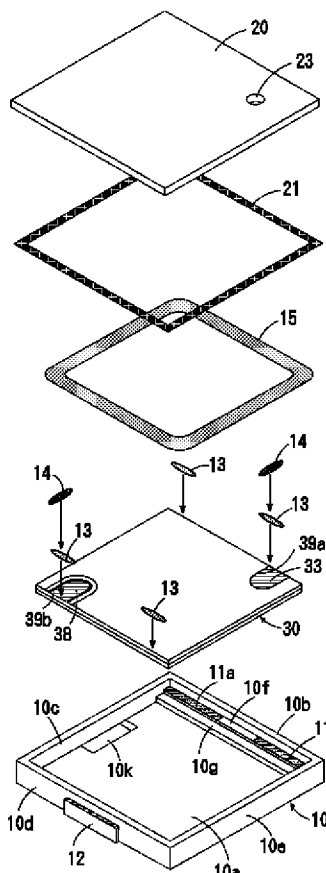
【図7】



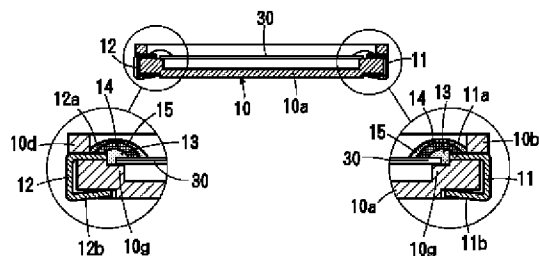
【図9】



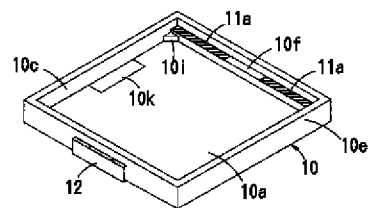
【図6】



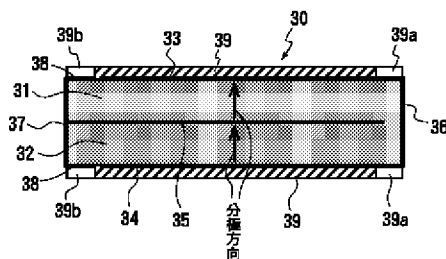
【図8】



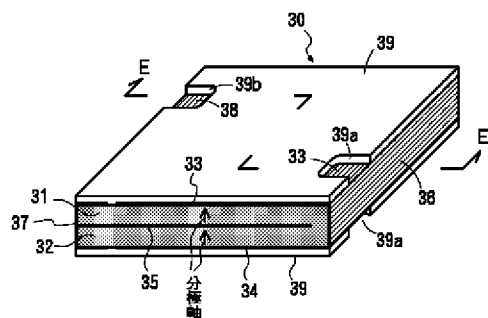
【図12】



【図11】



【図10】



フロントページの続き

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Fターム(参考) 5D004 AA02